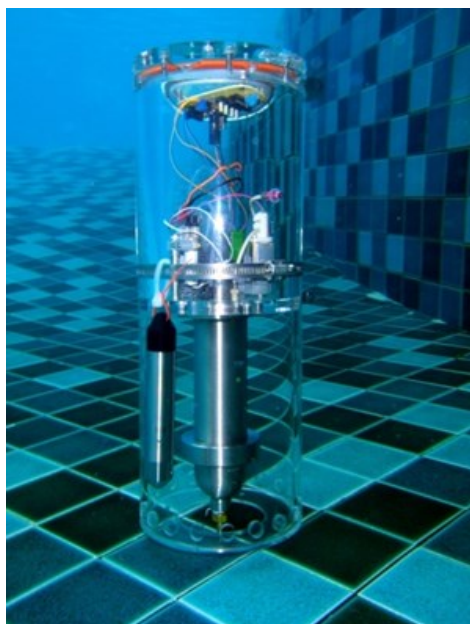




NRL
Naval Research Laboratory



Developed by the Naval Research Laboratory Bioenergy and Biofabrication Section in the Chemistry Division and the Physical Acoustics Branch of the Acoustic Division, the Zero Power Ballast Control (ZPBC) is a technology that relies on microbial energy harvesting developments to enable unsupervised underwater sensing with subsequent surfacing and reporting capabilities.

With an ultimate goal of producing simple, small, power-efficient data harvesting nodes with variable buoyancy the device will be able to monitor ocean temperatures with a stay time ranging from weeks to months and eventually years, providing a longer term than other mechanisms such as the Expendable Bathythermograph (XBT).

"Preliminary trials were successful in many ways," said Dr. Justin Biffinger. "The device surfaced and submerged periodically as designed via hydrogen gas produced from the microbial inoculum and growth medium, proving the device generated gas in sufficient quantity to produce buoyancy."

During testing of two ZPBC systems, the rise and fall of the devices were supported by on-board pressure and temperature sensor data and direct observation. The bacterial fuel source (inoculated gas production vessel) was then attached and the two ZPBC devices were deployed in situ off a military pier in Sattahip, Thailand, and held in place by mooring lines for seven days.

ZERO-POWER Bathythermograph Sensors

Using a low-power (1 to 10 milliwatt [mW]) timer, or only the rate of microbial gas generation that requires zero power input, the device can be alternatively configured to surface "on-demand." Sensors (e.g., acoustic, magnetic) attached to the ZPBC could be used to detect and classify, monitor the rise to the surface, report using RF or other communication, then re-submerge and continue monitoring operations.

The current device is composed of two chambers: the top, "dry" chamber containing the electronics, valves, solenoids, and timers; and the lower chamber, that contains the growth chamber (center tube) that becomes pressurized while bacteria are growing. The device is assembled on-site and has settings for duration between cycling (i.e., how often it comes to the surface, how long it should stay at the surface and how long the valve is open to allow gas to fill the lower chamber).

U.S. Navy

Reserve/Tom Boyd

In the future, the ZPBC will provide input for robust modeling of ocean temperatures and other parameters. The ZPBC could also be used to provide in-water optical data to enhance models for underwater visibilities, laser penetration depths, diver and target vulnerability assessments, electro-optical system performance predictions, and refining numerical models.

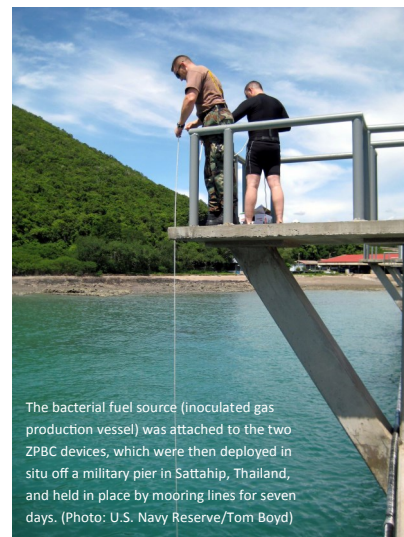
Military utility and scientific applications include use in Intelligence Surveillance and Reconnaissance (ISR), Anti-Submarine Warfare (ASW), Mine Warfare (MIW), Naval Special Warfare (NSW), and Meteorology and Oceanography (METOC). Continued prototyping could include geo-referencing capabilities so that the device could be untethered in future tests.

The Office of Naval Research (ONR)/Naval Research Laboratory (NRL) Reserve Program, (Program 38) was tasked to conduct an experiment on ONR and NRL technologies which were incorporated into the U.S. Marine Corps Forces Pacific (MARFORPAC) Experimentation Center (MEC) Crimson Viper 2010 (CV10) Field Experiment.

Crimson Viper is a Thai-US technology collaboration experimentation event jointly sponsored by the US Pacific Command (USPACOM) and the Royal Thai Defense Science and Technology Department (DSTD). The U.S. Marine Corps Forces Pacific (MARFORPAC) Experimentation

Center (MEC), under the leadership of its Director, Mr. Shujie Chang, acts as the Thailand Science and Technology (S&T) executive agent for USPACOM.

The BioEnergy and BioFabrication section has a wide range of biological expertise with a focus in energy and biofabrication applications. Bioenergy capabilities range from basic investigations into microbial metabolism and extracellular electron transfer mechanisms to more applied application of biological systems for energy production. Biofabrication efforts are focused on creating heterogeneous three-dimensional in vitro tissues via biological laser printing (BioLP) and the use of BioLP to isolate novel microorganisms from environmental samples. The Physical Acoustics Branch conducts a research and technology program aimed at developing new opportunities for exploiting physical acoustic and structural-acoustic-related phenomena, processes, and technologies in areas and systems of importance to the Navy, the Department of Defense and the Nation.



The bacterial fuel source (inoculated gas production vessel) was attached to the two ZPBC devices, which were then deployed in situ off a military pier in Sattahip, Thailand, and held in place by mooring lines for seven days. (Photo: U.S. Navy Reserve/Tom Boyd)



Technology Transfer

For more information contact:
Rita Manak, Ph.D. Head, Technology Transfer Office
(202) 767-3083
rita.manak@nrl.navy.mil